



Exploring the Influence of Argumentation on Epistemological Views of Science

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Abstract

Emerging research has suggested that engaging learners in argumentation may aid in the development of their NOS views, although this claim lacks empirical support. This study assessed the influence of a professional development program incorporating explicit argumentation in scientific contexts of instruction on five inservice secondary science teachers' views of NOS. Data sources included open-ended questionnaires and interviews. Data analysis indicated there was no substantial development in participants' views of NOS following participation in an argumentation professional development program. These results indicate that a professional development program emphasising explicit argumentation instruction in scientific contexts, without the incorporation of explicit NOS instruction, is not effective in enabling participants' views of NOS to be improved. Implications from this study highlight the importance of including explicit NOS instruction in studies that utilise argumentation as a pedagogical strategy to develop learners' views of NOS.

1. Introduction

There exists a general agreement in the science education community around the goal of enhancing learners' epistemological views of science, or *nature of science* (NOS) views, and this goal has been the focus of extensive research efforts for over 50 years [1][2]. Many reasons have been cited by science education researchers and reform organisations for developing learners' views of NOS, with perhaps the most fundamental reason positing that an understanding of NOS is necessary for achieving scientific literacy [3][4]. In addition, advances in technological innovations, and increasing globalisation, require students of the 21st century to handle vast, and often complex, sets of information from a variety of different sources. Students are expected to be able to evaluate this information, thus requiring them to engage in argumentation to arrive at evidence-based decisions [5]. The inclusion of argumentation in the curricula is an important component of contemporary science education in many countries [3][6], and many researchers have proposed that participating in argumentation aids in the development of scientific literacy [7][8].

2. Theoretical Framework

Despite the extensive amount of research conducted in the field and the prominence of this important component of scientific literacy in the reform documents, the development of informed NOS views has been a difficult goal to achieve, with many studies reporting difficulties in changing learners' NOS views [2]. Importantly, research has highlighted the effectiveness of explicit NOS instructional approaches in improving learners' views of NOS [9][10]. An explicit NOS instructional approach deliberately focuses learners' attention on various aspects of NOS during classroom instruction, discussion and questioning. Although explicit instructional approaches have been shown to be relatively more successful than implicit instructional approaches in developing learners' NOS views, studies continue to show the implementation of explicit NOS instructional approaches does not result in improved NOS views for all learners [11].

Scholars working from a sociocultural perspective [12][13] propose that engaging learners in scientific practices, such as argumentation, may lead to developments in their NOS views. Unfortunately, despite the worldwide trend to incorporate the teaching of argumentation in science classrooms via



recent reform recommendations and curriculum developments [5], and the recommendations stemming from research viewing argumentation as an important instructional strategy and educational goal for science education; both early, and more recent, empirical research indicates argumentation is rarely effectively incorporated in science classrooms [7][14]. Previous studies indicate that most classrooms are teacher dominated, with students given few opportunities to learn about, or engage in argumentation, and teachers generally do not possess adequate skills to teach argumentation to their students [15].

The purpose of this study is to explore the influence of a professional development program incorporating explicit argumentation on inservice secondary science teachers' views of nature of science (NOS). Specific research questions explored in this paper are: (1) What are inservice secondary science teachers' initial views of the examined aspects of NOS? (2) Do their views of these aspects of NOS change over the course of a professional development program focused on argumentation?

3. Methodology

This study was conducted with inservice secondary science teachers from a variety of high schools in the Gold Coast region of Queensland, Australia. Five teachers (3 female - Kate, Lisa, Rebecca; 2 male – Peter, Brian) were selected for intensive investigation, and became the focus participants in the study. These teachers participated in an argumentation-based, professional development program over three days. Argumentation instruction was explicitly implemented during the program by incorporating teaching materials developed from the Ideas, Evidence and Argument in Science Project 'IDEAS' [16]. These materials have been specifically designed to support the teaching of ideas, evidence and argument in school science education, and placed a primary emphasis on the development of scientific reasoning. Further details of the program are provided in [17].

Two sources of data were utilised in this study: questionnaires (VNOS-C), and interviews. The Views of Nature of Science Questionnaire 'VNOS-C' and associated semi-structured interviews were utilised to assess participants' pre- and post-intervention NOS views. After the administration of the written questionnaire, the participants were individually interviewed to clarify their responses to the questionnaire items. Data analysis was conducted at the conclusion of the study, and participants' views of the examined aspects of NOS in this study were coded on a continuum, as either naïve, limited, partially informed, or informed. Four researchers (including the author and three science educators experienced in NOS research) coded at least 30% of the data independently, with the first author coding 100% of the data, to ensure the reliability of the coding scheme.

4. Results and Discussion

A summary of individual participants' pre- and post-intervention views of each of the examined NOS aspects is provided in Table 1. Prior to the professional development program, participants exhibited a range of overall NOS views, from predominately naïve/limited views, to predominantly partially informed/informed views. Little change was evident in participants' overall NOS views at the end of the study, with results indicating no substantial improvement. No apparent trends were identified in the data pertaining to the development, or lack thereof, of particular NOS aspects. The three participants (Lisa, Peter, Brian) who experienced regression in their views of a particular NOS aspect, all experienced this regression across different NOS aspects (methods of science, tentative NOS, subjective and theory-laden NOS). Additionally, the few incidences of development in NOS aspects experienced by four participants (Kate, Lisa, Peter, Brian) were evident across different NOS aspects (empirical NOS, tentative NOS, creative and imaginative NOS, theories and laws, social and cultural NOS, inference and theoretical entities).

5. Conclusions



In contrast to the findings reported in the literature [18][19], the results of this study do not lend support for the claim that engaging learners in argumentation in scientific contexts leads to developments in their views of NOS. Findings from this study indicated that no substantial development in learners' NOS views was evident after participation in a professional development program incorporating explicit argumentation instruction in scientific contexts. These findings also lend support for the emerging body of research recommending the inclusion of explicit NOS instruction, in addition to explicit argumentation instruction, in studies that aim to improve learners' NOS views [20][21]. Thus, it is recommended to include explicit attention to specific NOS aspects incorporated at appropriate intervals during argumentation-based interventions to provide cognitive anchor points to allow learners to access and engage in epistemological discourse during argumentation. A conscious awareness of the various aspects of NOS is needed for learners to apply their epistemological views to their arguments. Explicit NOS instruction and guidance in applying NOS understandings is imperative to fulfil this role.



Table 1 Summary of participants' NOS views

NOS Aspect	Kate			Lisa			Rebecca			Peter			Brian		
	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
Empirical	-	+	D	-	-	U	++	++	U	+	+	U	+	+	U
Methods of science	-	-	U	+	-	R	-	-	U	-	+	D	-	-	U
Theories and laws	--	--	U	--	-	D	-	-	U	-	-	U	-	-	U
Tentative	-	+	D	-	-	U	+	+	U	+	-	R	+	+	U
Inference and theoretical entities	--	--	U	--	--	U	+	+	U	+	+	U	-	+	D
Subjective and theory-laden	-	-	U	-	-	U	++	++	U	+	-	R	-	-	U
Social and cultural	-	-	U	--	-	D	++	++	U	-	-	U	+	+	U
Creative and imaginative	-	+	D	-	-	U	+	+	U	+	+	U	+	+	U
TOTAL + or ++	0	3		1	0		6	6		5	4		4	5	
TOTAL - or --	8	5		7	8		2	2		3	4		4	3	
TOTAL D or SD			3			2			0			1			1
TOTAL R			0			1			0			2			0

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